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Optimizing gradient functional material for enhanced performance of solar-driven thermochemical fuel production

Friday, 4 June 2021 09:40 (1 hour)

Porous media is the key energy conversion media in two-step solar thermochemical fuel production devices. The conventional way of fabricating porous metal oxide structure shows limited flexibility in varying local morphology for better transport properties. The material structure optimization is hindered by lack of methodology precisely tuning material structure and lagged modeling framework to assess the structure-property relationship of designed materials. This structure-property knowledge can be further linked to the final solar-to-fuel efficiency of reactors using such material. The triply periodic minimum surface (TPMS) structures are promising candidates due to their flexible lattice structure design, well-defined analytical expression, and easiness in anisotropic feature introduction. Moreover, the recent development of direct ceramic 3D printing technologies enables a unique route for the fabrication of gradient functional materials with complex structures.

In this study, we focused on the optimization of TPMS structures' transport properties and their impacts on the thermochemical behaviors. Volume-averaged TPMS morphological properties, radiative transfer properties, as well as effective mass and heat transfer properties are evaluated by a comprehensive in-house modeling framework. The transport properties obtained was then used in continuum multi-physics model for the evaluation of the thermal and thermochemical performance of a cylindrical cavity reactor. The model was validated with a complete discrete model at pore-level. Via screening TPMS structures' under various design geometrical parameters, design guidelines for macro-structure of porous reacting media for thermochemical fuel process will be provided.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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